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PATENT- OCH REGISTRERINGSVERKET

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# SYSTEM FOR LIQUID PURIFICATION

## TECHNICAL AREA

The present invention relates to a system for purifying liquid, and in particular water, by oxidizing contaminants in the liquid.

## BACKGROUND OF THE INVENTION

There is an ever increasing need for purifying liquids, and in particular water. There are a number of applications where water needs to be purified and decontaminated, and a few of these are swimming pools and recreational baths, green houses, animal farms, cooling towers, hospitals etc. The conventional technologies for purifying and decontaminating water for most applications include the use of chemicals that are mixed with the water. Due to environmental aspects and the impact that chemicals have on the environment, humans and animals, there is a strive to reduce the use of chemicals.

One approach to purify/decontaminate water has been to use ozone. Several methods have been developed in several countries for purifying water with ozone ($O_3$) in drinking water installations and bathing facilities, and also ozone dissolved in water for cleaning, disinfection and sterilization of articles. A combination of ozone, oxygen, hydrogen peroxide and UV radiation means that the reaction proceeds much more quickly and more efficiently by virtue of the generation of more free radicals.

The inactivation of microorganisms with the aid of ozone and radicals is considered as an oxidation reaction. The membrane of the micro-organism is the first to be attacked. Within the membrane/cell wall, the ozone and the radicals destroy nuclear material inside the cell/virus/spore. The inactivation reaction in the case of most micro-organisms occurs within minutes, depending on the ozone dose and the amount of free radicals which are formed.

Despite its solubility in cold water, ozone is broken down (=consumed) quickly, as is the case in air, which gives a great many different radicals and more or less stable by-products such as aldehydes, bromate and carboxylic acids. The degree of breaking down depends on the pH, the substance which is exposed and the temperature. Certain substances are broken down easily by the ozone. However, the majority of substances and molecules are oxidized more efficiently by free radicals which are formed by ozone and the media treated by ozone.

One very efficient method of using free radicals in the oxidizing process is disclosed in the international patent application No. WO 96/20017. The method utilises UV-radiation to create ozone in air and liquid, radiates the ozone with certain wave-lengths in order to obtain free radicals, which oxidize the contaminants in the air or liquid. In order to increase the production of free radicals, catalysts are used, for example titanium oxides. The applicant of the above patent application has obtained very good results in purifying/decontaminating water in cooling towers, swimming pools, green houses, to name a few applications. The use of the patented method has enabled a complete removal of chemicals in those applications.

However, for certain applications, the device for purifying water or other liquids described in WO 96/20017 has capacity limitations as regards the amount to be treated per time period. Trials have been made to reduce the flow past the UV-radiation sources, to use the device also during periods when no consumption of water is taking place and to store the purified water in intermediate tanks. This has the drawback that additional space has to be available in order to accommodate the intermediate tanks. For some applications this might not be feasible and for some applications and large consumers it is not an optimal solution. There has also been a need from customers to be able to arrange the device so that minimal floor space is occupied.

Another application with specific problems is found in water systems in building. This is in connection with legionella bacteria, a water-based organism which causes infection when inhaled in an aerosol form, which is a huge problem all over the world, and is especially troublesome in hospitals, if already weak and sick people receive the bacteria via for example showers. If the tap-water is not hot enough the bacteria may thrive and multiply uncontrolled. The main solution to this problem has been to increase and to try to control the temperature of the water in order to prevent the occurrence of legionella bacteria. Chemicals that are able to kill these bacteria cannot usually be used for these applications since they may be harmful also to humans.

There is thus a need for improvements in this technical area.

## BRIEF DESCRIPTION OF THE INVENTION

The invention aims at solving the above mentioned problems with a system according to the characterising part of claim 1. preferable embodiments of the invention are covered by the dependent claims.

According to a main aspect of the invention it is directed to a system for treating liquids, and in particular water, including through-flowing means provided with inlets and outlets for the liquid, UV-light generating means arranged in the through-flowing means, capable of generating ozone in the through-flowing liquid and at the same time break down the ozone in order to produce free radicals, characterised in that mountable and demountable connection means are arranged to the inlet and outlet of the through-flowing means.

According to another aspect of the invention the system is characterised in that it is arranged with at least two through-flowing means and that preferably that each through-flowing means is designed as an elongated pipe.

According to yet an aspect of the invention, the UV-light generating means is arranged in one end of the elongated pipe and that ceramics is arranged on the inside of the through-flowing means at least adjacent said UV-generating means.

According to a preferred embodiment of the invention at least two of the said through flowing means are arranged in series, whereby the first through-flowing means is connected to an inlet pipe for liquid to be treated and that the last through-flowing means is connected to an outlet pipe for the treated liquid and/or are connected in parallel to an inlet pipe for liquid to be treated and an outlet pipe for the treated liquid.

According to a further aspect of the invention the through-flowing means is arranged adjacent a water outlet for human use like for example a shower head.

The advantages with the present invention are several. By arranging the through-flowing means with mountable and dismountable means it is very easy and convenient to vary the through-put through the system depending on the capacity requirements. One or several through-flowing means with UV-radiating lamps can be placed after each other, ie. in series, either directly or via bends, which enables the system to be adapted to the space available without for example taking up too much floor space. For a substantial increase of the system one or more through-flowing means may be arranged in parallel with a first inlet/outlet connected to an inlet pipe and the second inlet/outlet connected to an outlet pipe.

By using the components of the system in series and/or in parallel the through-put may be varied almost infinitely. Several parallel arrangements of the system may be arranged in series in order to treat

heavily contaminated water several times. The system is also based on standard components and fittings and reduces the need of special components in that standard lengths of through-flowing means with lamps can be combined with standard bends and connections to the water supply that is to be treated.

When placing a through-flowing means in connection to the outlet for a shower, one obtains the special advantage of taking care of the risk of being infected with legionella bacteria. Because of the pronounced risk of legionella in large tap water systems and the difficulties of exterminating them in such systems, the present invention removes the risk of any such bacteria leaving the water system. This is a clear advantage over the present solutions thereby completely eliminating the problem without any chemicals and without any risk for the users of water in these systems.

These and other aspects of, and advantages with, the present invention will become apparent from the following detailed description of the invention and from the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the follow detailed description of the invention reference will be made to the drawings, of which

Fig. 1 shows a central component, a through-flowing means, for treating contaminated liquid, comprised in the present invention,

Fig. 2 shows different components that may be included in the present invention,

Fig. 3 shows one example of the use of the components of Fig. 1 to obtain the present invention,

Fig. 4 shows another example of the use of the components, and

Fig. 5 shows the installation of a decontaminating unit in connection with a shower head.

## DETAILED DESCRIPTION OF THE INVENTION

The present invention utilises UV lamps emitting light within specific spectra. The liquid to be treated is exposed to UV radiation with a spectral distribution within the range of 180 - 400 nm. The wavelength of 183.7 nm in particular converts the oxygen in the medium to ozone molecules ($O_3$). The ozone molecules formed are at the same time decomposed by radiation within the abovementioned wavelength range, especially at a wavelength of 254 nm. At the same time, the $O_3$ formed is broken down to form atomic oxygen. In order to increase the efficiency during generation of free radicals, in particular $OH^-$ radicals, oxides are added as catalysts.

The present invention utilises the principle of using free radicals for purifying liquid, and in particular water. The system consists of at least one substantially straight pipe, 10, Fig. 1. The pipe is made of preferably titanium or some other material lined with titanium on the inside. The titanium on the inside of the pipe is treated to obtain a ceramic titanium oxide. The titanium oxide acts as a catalyst during the forming of free radicals, ie. the titanium oxide increases the amount of free radicals produced per time period. In one variant, a plastic pipe has been used, lined with titanium oxide. It is of course possible to utilize other highly resistant materials and to use catalysts as described in WO 96/20017 but experience has shown that the use of titanium pipes or pipes lined with titanium have provided excellent resistance against the very corrosive environment that the purification/decontamination results in.

In the embodiment shown in Fig. 1 one end of the pipe is provided with an end wall 12. A passage 14 is arranged in the end wall and an UV radiating light source 16 is arranged in the passage with a surrounding housing 18, providing UV radiation with wave lengths of 185 and 254 nm. These wave lengths have excellent properties in generating ozone in the water and then at the same time breaking down the ozone to free radicals. The housing is preferably provided with light emitting wall part 20 for the convenience of the user in displaying if the lamp is working or not. Previously a watching hole was arranged in the pipe, which was prone to be blocked by sediment and also to leakage. A drive unit for the UV lamps is also provided, not shown. A control unit for controlling one or several of the drive units is also provided, not shown. The design and function of the drive units and the control unit is mere routine work for the man skilled in the art and will not be described in more detail.

A first inlet/outlet 22 is arranged on the pipe wall adjacent the end wall, which inlet is arranged with suitable flanges 24 or other suitable connection means for connection to other piping. The inside of the pipe is treated to obtain titanium oxide for increasing the amount of free radicals produced by the UV radiation. The treatment to obtain titanium oxide may for example be done by etching the titanium pipe or the layer. The end of the pipe opposite the UV lamp is arranged as the second inlet/outlet 26, provided with suitable flanges 28 or other connecting means for connection to other piping.

As shown in Fig. 2 the system comprises pipe bends 30, for example 90° or 180° but of course other angles are possible. Also these parts, even though not provided with any UV-radiation means, are preferably made of titanium or lined with titanium. Fig 1 also shows a few connection alternatives for combining the components of the system, like connecting two straight pipes by inter-connecting their second

inlets/outlets either directly like in 32, via a 90° bend like in 34 or via a 180° bend like in 36.

Fig 3 and 4 show a "parallel-connected" system where two straight pipe sections 32, 34, 36 provided with UV lamps are inter-connected with their second inlets/outlets to each other, so in fact there is a "back-flow" in one of the pipes. Several of these inter-connected pipes are placed in parallel where the first inlets/outlets 22 of one of the inter-connected pipes are connected to a common inlet pipe 40 and where the first inlets/outlets of the other inter-connected pipes are connected to a common outlet pipe 42. In this case the water to be treated is fed via the inlet pipe 40, where the opposite end of the inlet pipe is closed by a wall 44, and in parallel through the inter-connected pipes 32 where the water is irradiated by the UV-lamps of both pipes. The water is then fed through the water outlet pipe 42. In the same manner the end of the outlet is closed by a wall 44.

The configuration enables both an increased capacity in that a large number of pipes including UV-radiating means can be connected depending on application and capacity requirements and also that walls and ceilings may be taken into use for setting up the system. In other words, very little floor space has to be utilized, which may be of importance for applications where space is limited. With the components it is further easy to adapt the system to existing layout of the space to be used, rather than to rebuild the space in order to fit the purifying system.

Fig. 4 shows another example where three parallel-connected units have been connected to main inlet and outlet pipes, where the units have been placed on the walls and ceilings and also around corners. The system is thus very versatile. It is to be understood that other designs of the components of the pipe system may be used without departing from the scope of the invention.

In this context it is also to be understood that lamps with different power may be used and that additional oxygen may be added by appropriate means in order to increase the amount of ozone and thus of free radicals. When the water is heavily contaminated, or when large amounts of free radicals in the water is needed, it is also conceivable to include an ultrasonic device placed in the vicinity of the UV-lamps. High amplitude ultrasonic waves generate free radicals and break contaminants.

One specific application where the system of the present invention may be utilized is for preventing legionella bacteria in connection with showers, which is a potential infection point because the bacteria may cause infection when inhaled in an aerosol form. In the embodiment shown in Fig. 5 a pipe 70 including an UV-lamp as described above is connected to the outlet of a water faucet 72 in a shower or similar water outlet. The water from the faucet is led through the pipe where it is irradiated by the UV-lamp whereby ozone is created, and whereby at the same time the ozone is broken down into free radicals, which react with and destroys the legionella bacteria. The number of free radicals is increased by the titanium oxide on the inside of the pipe. In this context it is to be pointed out that the life span of the free radicals is extremely short and there is thus no risk whatsoever that free radicals can exit through the shower head 74. The inclusion of a disinfecting system according to the invention completely removes the risk of legionella bacteria to be spread to humans. It is also to be noted that in contrast to most devices using UV-light sources, where the light is switched off during non-use due to eg. energy consumption, the present device is switched on all the time in order to ensure that no legionella bacteria can pass the device and settle beyond the it. This is feasible due to the very low energy consumption needed for this particular application.

As an alternative, the pipe 76 may of course be connected to the inlet of the warm water 78 to the faucet 70, ie. before but in connection with, the faucet.

It is to be understood that the embodiments described above and shown in the drawings are to be regarded as non-limiting examples of the invention and that the scope of protection of the invention is defined by the patent claims.

PATENT CLAIMS

1. System for treating liquids, and in particular water, including through-flowing means provided with inlets and outlets for the liquid, UV-light generating means arranged in the through-flowing means, capable of generating ozone in the through-flowing liquid and at the same time break down the ozone in order to produce free radicals, characterised in that mountable and demountable connection means are arranged to the inlet and outlet of the through-flowing means.

2. System according to claim 1, characterised in that it is arranged with at least two through-flowing means.

3. System according to claim 2, characterised in that said through-flowing means are arranged in series, whereby the first through-flowing means is connected to an inlet pipe for liquid to be treated and that the last through-flowing means is connected to an outlet pipe for the treated liquid.

4. System according to any of the claims 2-3, characterised in that at least two of the said through flowing means are connected in parallel to an inlet pipe for liquid to be treated and an outlet pipe for the treated liquid.

5. System according to any of the preceding claims, characterised in that the through-flowing means is designed as an elongated pipe.

6. System according to claim 5, characterised in that the UV-light generating means is arranged in one end of the elongated pipe.

7. System according to any of the preceding claims, characterised in that ceramics is arranged on the inside of the through-flowing means at least adjacent said UV-generating means.

8. System according to claim 7, characterised that the ceramics is titanium oxides.

9. System according to any of the claims 1, 5-8, characterised in that the through-flowing means is arranged adjacent a water outlet for human use, like a shower head.

10. System according to claim 9, characterised in that the through-flowing means is arranged between a water faucet and the water outlet.

11. System according to claim 9, characterised in that the through-flowing means is arranged between a warm water pipe and a faucet connected to the water outlet.

ABSTRACT

The present invention relates to a system for treating liquids, and in particular water, including through-flowing means provided with inlets and outlets for the liquid, UV-light generating means arranged in the through-flowing means, capable of generating ozone in the through-flowing liquid and at the same time break down the ozone in order to produce free radicals. The invention is characterised in that mountable and demountable connection means are arranged to the inlet and outlet of the through-flowing means.

(Fig. 1)

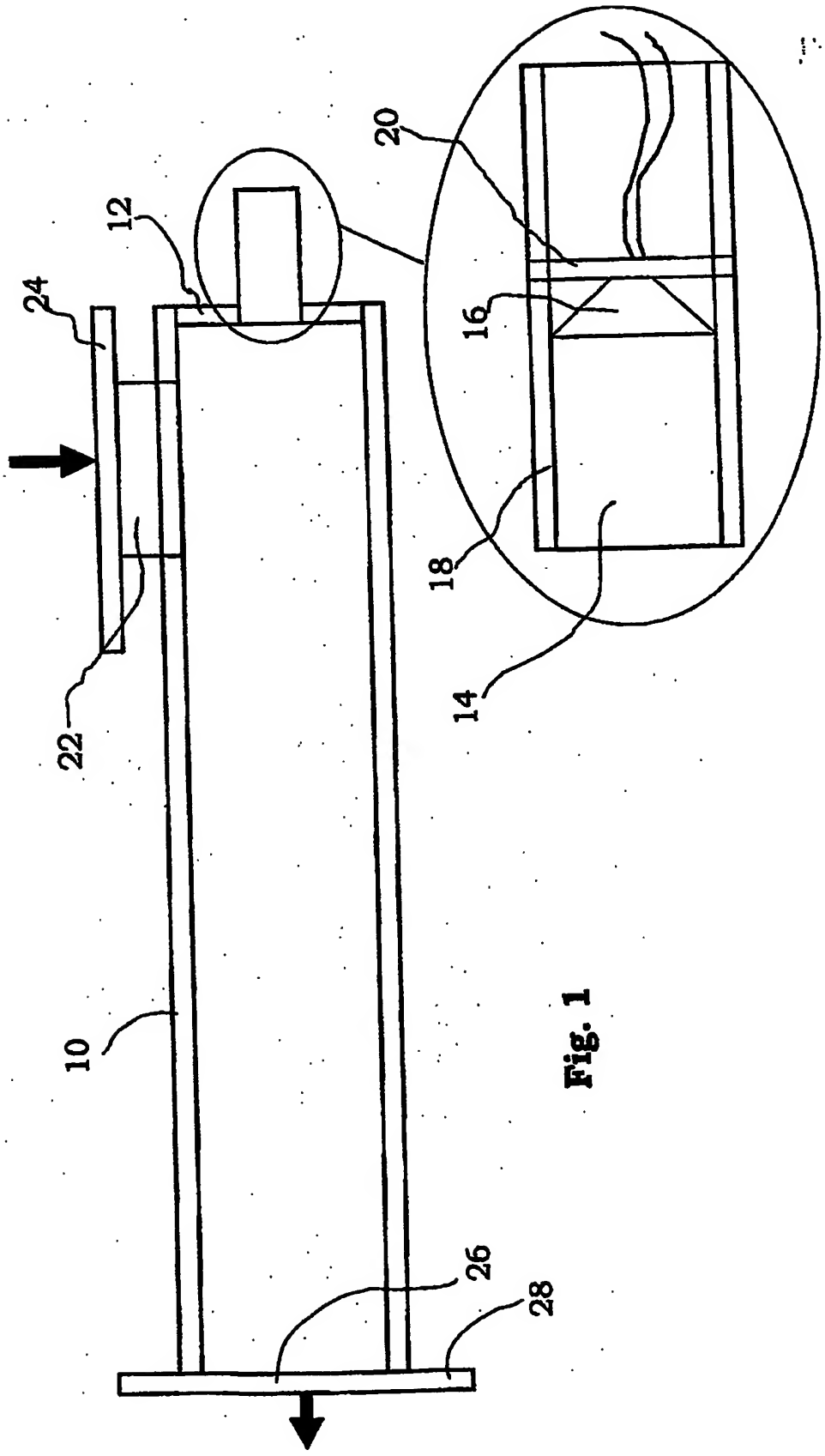


Fig. 1

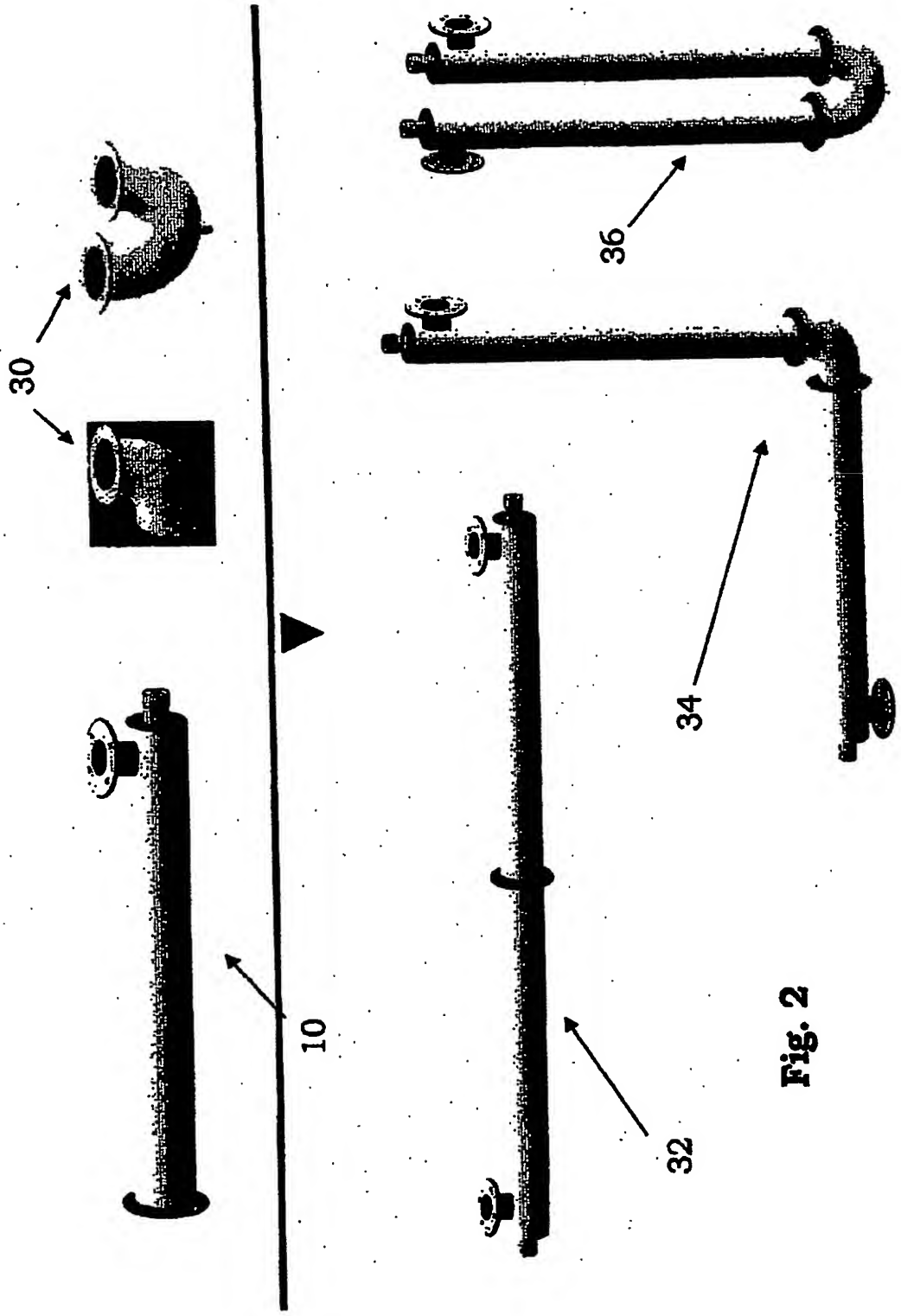


Fig. 2

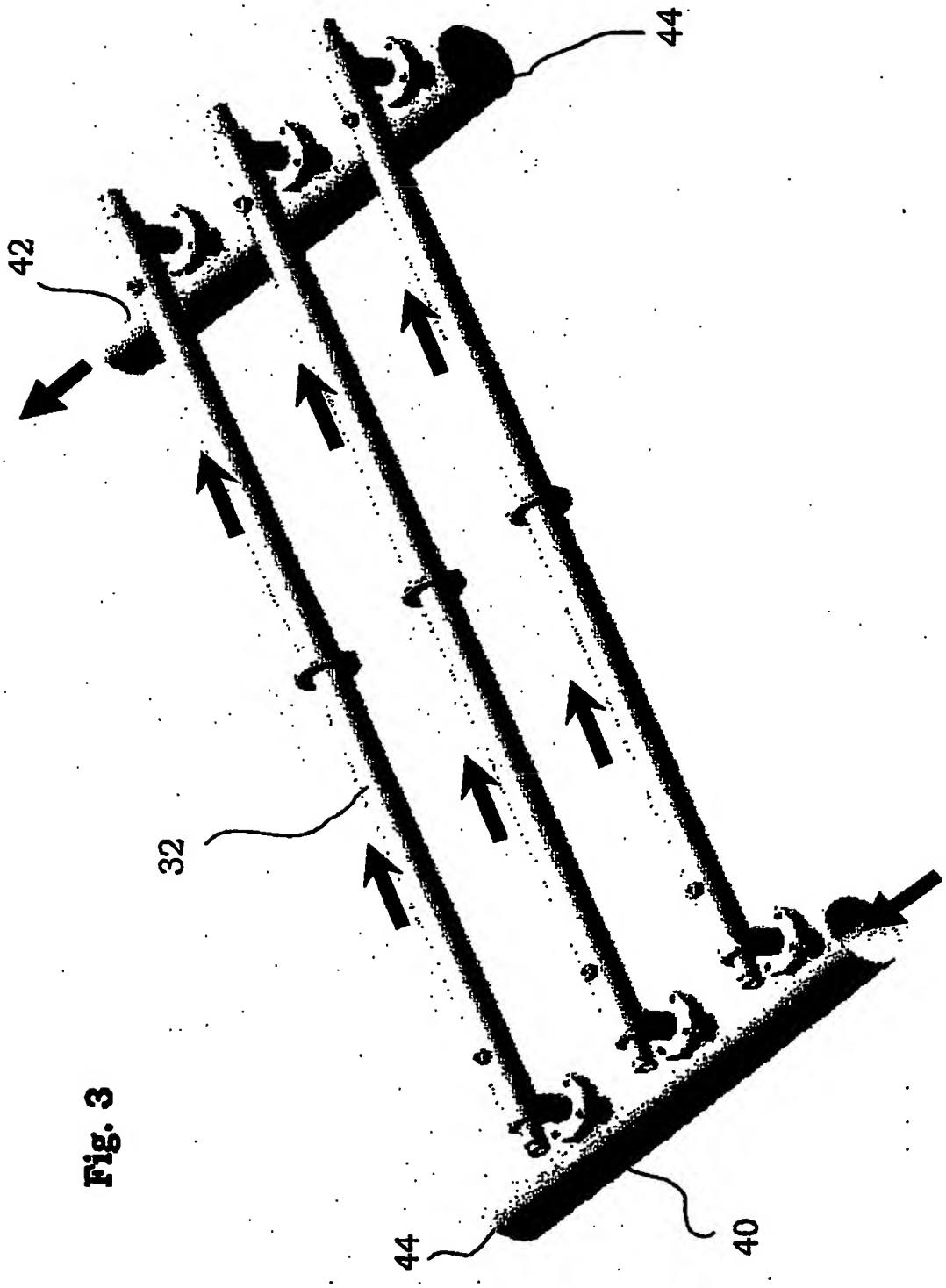


Fig. 3

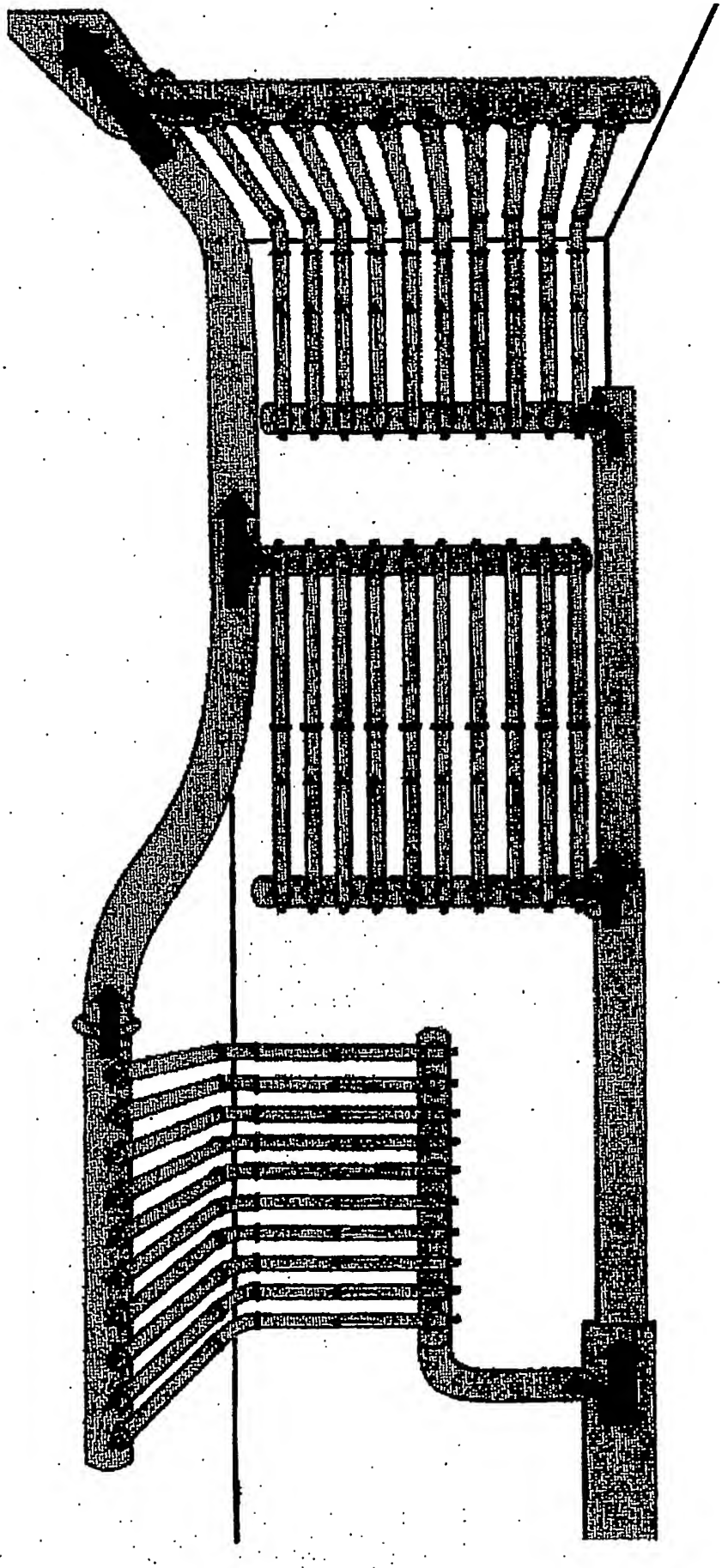

Fig. 4

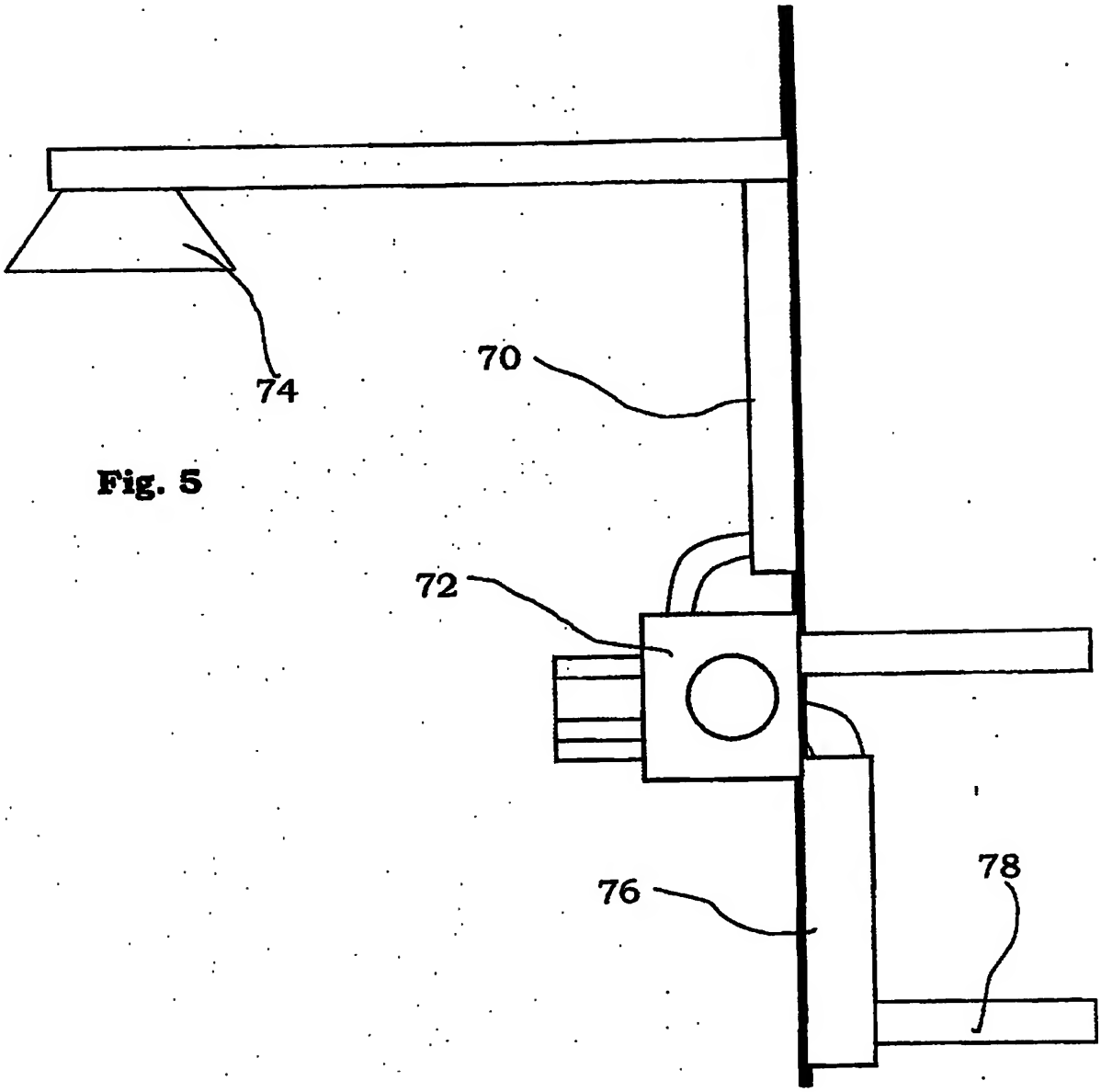


Fig. 5